

(12) UK Patent Application (19) GB (11) 2 313 197 (13) A

(43) Date of A Publication 19.11.1997

(21) Application No 9709121.9

(22) Date of Filing 07.05.1997

(30) Priority Data

(31) 9609593

(32) 08.05.1996

(33) GB

(71) Applicant(s)

Advanced Energy Monitoring Systems Limited

(Incorporated in the United Kingdom)

**The Energy Centre, Finnimore Industrial Estate,
Ottery St. Mary, Devon, EX11 1NR, United Kingdom**

(72) Inventor(s)

Maurice Alan Yates

(74) Agent and/or Address for Service

**Alpha & Omega
Chine Croft, East Hill, OTTERY ST. MARY, Devon,
EX11 1PJ, United Kingdom**

(51) INT CL⁶

G01F 1/00 , G01L 3/26

(52) UK CL (Edition O)

**G1N NAAJR NABF N3S1A N4B N7B1 N7F
U1S S2003 S2150**

(56) Documents Cited

GB 2260406 A

EP 0674154 A1

US 4781525 A

US 4108574 A

(58) Field of Search

**UK CL (Edition O) G1N NAAJD NAAJR NABF NADW
INT CL⁶ G01F 1/00 1/34 , G01L 3/26
ONLINE: WPI**

(54) **Measuring pump flow rate**

(57) A method of measuring the flow rate of a pump comprises:

- a) collating data concerning the power consumption of the pump and the flow rates obtained under initial or optimal conditions,
- b) obtaining information as to the actual power consumption of the pump, and
- c) comparing said information with the collated data (and carrying out any necessary calculations) to obtain a flow rate measurement.

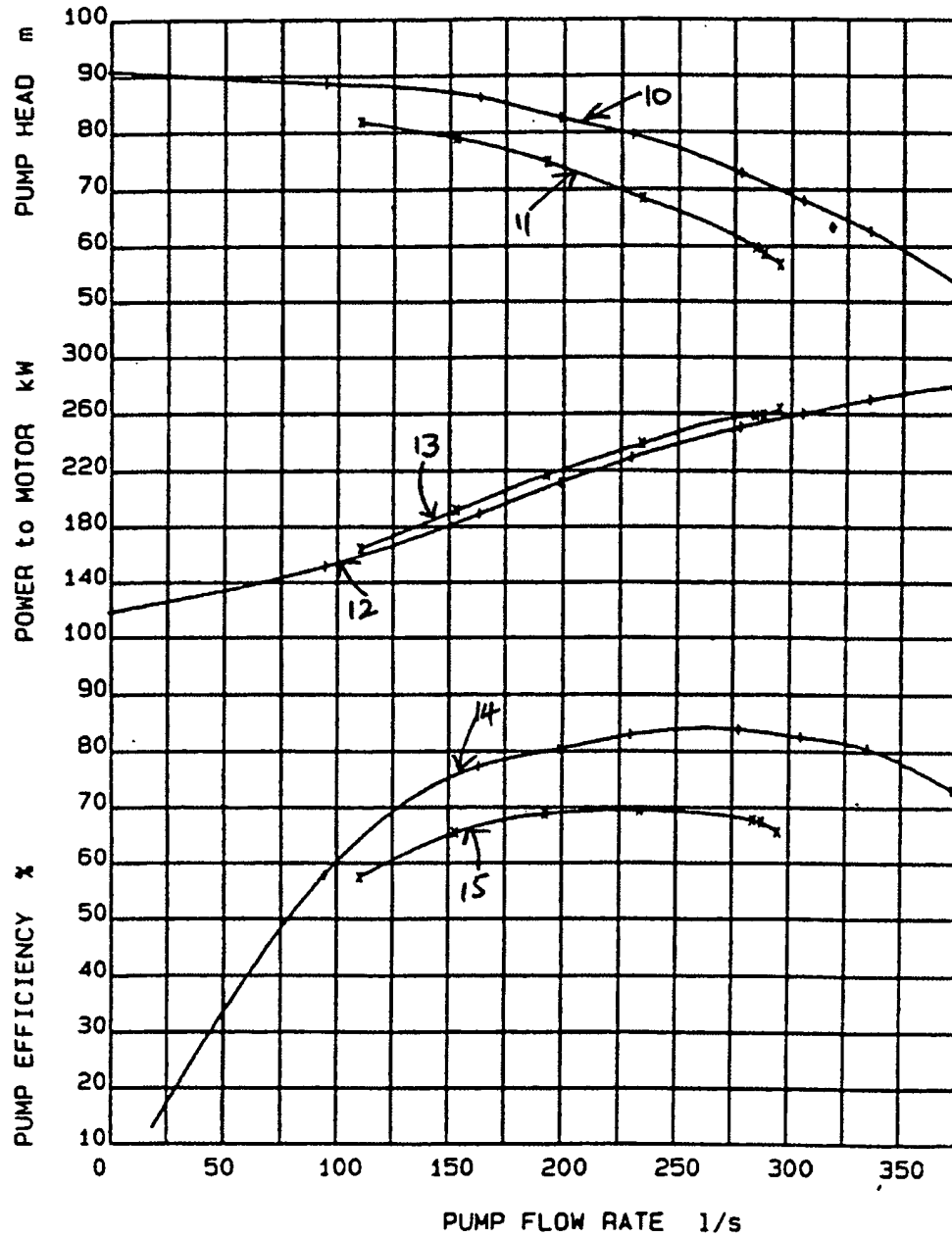
The method may be used to obtain individual flow rates of a number of pumps operated in parallel, or combined with pump head measurements to obtain an indication of pump performance.

GB 2 313 197 A

WORN PUMP

Pump : No.3 Tester : AW Test date : 15-10-1991

AEHS TEST* MANUFACTURERS ORIGINAL WORKS TEST* DUTY POINT*



Typical worn pump

FIG. 1

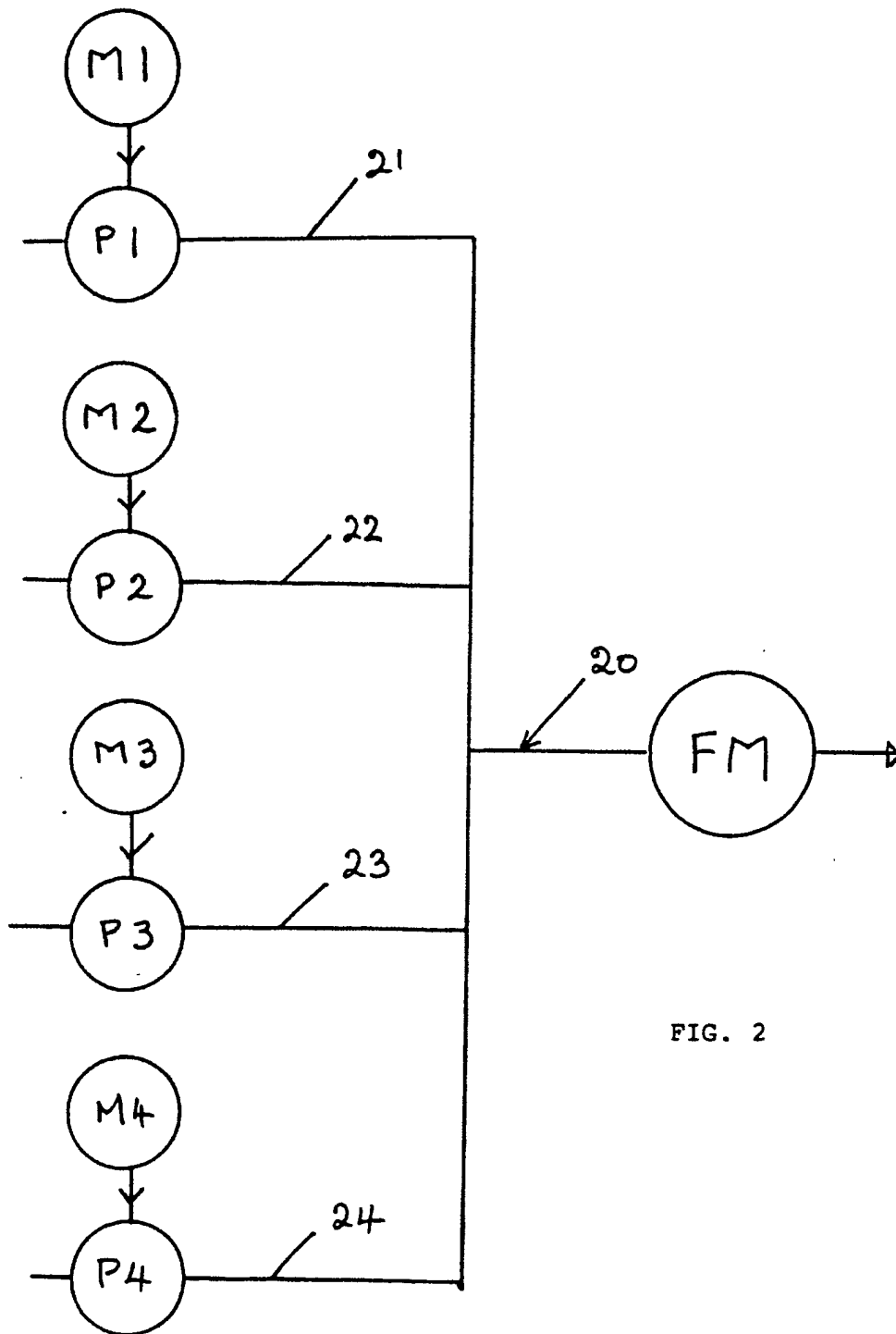


FIG. 2

2313197

PUMPS

Field of the Invention

This invention relates to pumps, for example, pumps used for pumping water and sewage and pumps used in a pumping station for pumping water out of an underground supply. The invention also relates to the measurement of flow through a pump.

Background to the Invention

Information is often required concerning the flow rate of the fluid being pumped and many types of flow meters have accordingly been developed.

There are, however, situations in which it can be either very difficult or very expensive to measure flow rates. For example, there is at present no satisfactory way of obtaining accurate measurements for the flow rates obtained during operation of sewage pumps and activated sludge pumps. The principal reason for this is that many pumping installations are such that the pipework configuration is not conducive to accurate measurements by the traditional methods, for example, using magnetic and ultrasonic flow meters.

There are also situations in which one or more pumps are arranged to operate in parallel and, although the combined flow rate

is determined (since this is the parameter for which precise control is required), the individual flow rates attributable to the separate pumps are not measured.

It is accordingly an object of a first aspect of the present invention to provide an improved method for measuring the flow rate obtained during operation of a pump.

In use, a pump will be subject to wear and, as the degree of wear increases, the efficiency of the pump is reduced and the cost of operation of the pump to obtain a predetermined output is increased. Pump refurbishment is, however, expensive and the operators, for example, water companies, do not wish to carry out refurbishment unless and until they are satisfied that refurbishment will actually produce a cost saving.

It is accordingly an object of a second aspect of the present invention to provide an improved method of determining the performance of a pump.

Summary of the Invention

According to a first aspect of the present invention there is provided a method of measuring the flow rate obtained during operation of a pump, which method comprises:-

- a) collating data concerning the power consumption of the pump and the flow rates obtained under initial or optimal conditions,
- b) obtaining information as to the actual power consumption of the pump during operation thereof, and
- c) comparing said information with the collated data (and carrying out any necessary calculations) to obtain a flow rate measurement.

Where a plurality of pumps are arranged to operate in parallel so as to obtain a combined flow rate, the combined flow rate may be measured using a flow meter and the flow rates attributable to the individual pumps may be measured by determining the power consumptions of the individual pumps and carrying out the appropriate computations.

The data concerning the power consumption of the pump and the flow rates obtained under initial or optimal conditions may be the data supplied by the pump manufacturer on initial installation of the pump, or it may be data derived from initial trials carried out on site.

The relationship between the power consumption of the pump and the flow rates obtained during initial or optimal conditions may be one of three curves supplied by the pump manufacturer to the user of the pump, the other two curves showing the relationship

between the pump head and the pump flow rate and the relationship between the pump efficiency and the pump flow rate.

In the case of pumps which have complex power/flow curves, i.e. high specific speed pumps, the method may be enhanced by cross-referencing the head/flow curve to the power/flow curve.

Thus, if $Q_1 = f P_1$,

and $Q_1 = f H_1$,

where Q = flow, P = power and H = head,

then Q can be defined either as a function of P , or as a function of H , or as the average of a function of P and a function of H .

The algorithm used in the calculation of flow may accordingly be selected to use the most sensitive method. For example if $dP/dQ > dH/dQ$, then the function $Q = fP$ is used. On the other hand, if $dP/dQ < dH/dQ$, then the function $Q = fH$ is used. In addition, if dP/dQ is approximately equal to dH/dQ , then the function $Q = (fP + fH)/2$ is used.

According to a second aspect of the present invention, there is provided a method of determining pump performance, which comprises the following steps:-

a) measuring the flow rate of the pump by the method defined above,

b) measuring the pump head,

- c) collating data concerning the pump head and the flow rates obtained under initial or optimal conditions, and
- d) comparing the results of said measurements with the collated data (and carrying out any necessary calculations) to obtain an indication of pump performance.

Pressure transducers are preferably provided at the pump inlet and outlet to determine the pump head, i.e. the difference between the pressure at the pump outlet and the pressure at the pump inlet plus any velocity head difference between the suction pressure point and the discharge pressure point and any static head difference between the two measuring points.

The information obtained may be expressed in terms of pump efficiency expressed as a percentage of the present pump efficiency in relation to the initial pump efficiency.

With information as to the pump efficiency expressed in this form, further calculations can be carried out to obtain a more accurate determination of the pump flow rate as compared to the actual power consumption.

The information concerning pump efficiency can also be used to carry out an assessment of the need for pump refurbishment.

Brief Description of the Drawings

Figure 1 shows a number of operational curves for a typical worn pump, and

Figure 2 is a diagrammatic illustration of a system including four pumps for pumping water from an underground source to a reservoir.

Description of the Preferred Embodiment

Six curves are shown in Figure 1, as follows:-

- a) curve 10 shows the relationship between pump head and pump flow rate for a new pump, i.e. in accordance with the data supplied by the pump manufacturer or as a result of readings taken on installation of a new pump,
- b) curve 11 shows the relationship between pump head and pump flow rate after the pump has been in use for a significant length of time and its condition is such that pump refurbishment should be considered,
- c) curve 12 shows the relationship between the power supplied to the motor driving the pump and pump flow rate for a new pump,

- d) curve 13 shows the relationship between the power supply to the motor and pump flow rate for the worn pump mentioned above,
- e) curve 14 shows the relationship between the pump efficiency and pump flow rate for a new pump, and
- f) curve 15 shows the relationship between the pump efficiency and the pump flow rate for the worn pump mentioned above.

When a pump is supplied to, for example, a water treatment works or a waste water works, the manufacturer will supply the pump user with information containing curves 10, 12 and 14 so as to assist the user in operating the pump at maximum efficiency. When, however, the pump is in use and wear has taken place to an extent such that pump refurbishment is due, the relationship between efficiency and pump flow rate will have changed from curve 14 to curve 15.

There are a large number of flow meters currently available for measuring many different types of fluid flow. There are, however, as explained above, none that can currently be used for measuring the flow rates achieved by activated sludge pumps used for pumping raw activated sludge.

The pump operator can, however, be made aware of the power (or can himself measure the power) which is being

consumed by the motor which is driving the sludge pump. Once information of power consumption is obtained, curve 12 will enable the pump operator to obtain an initial approximate indication of the pump flow rate. As a result of wear of the pump, the relationship between the pump power consumption and the fluid flow rate will be represented more accurately by curve 13 and additional calculations will accordingly preferably be carried out to obtain a more accurate indication of the flow rate. Such additional calculations may, as described above, include the use of the relationship between the pump head and the flow rate.

Turning next to Figure 2, this shows schematically an arrangement in which four pumps P1, P2, P3 and P4 are driven by respective motors M1, M2, M3 and M4 to pump water from, for example, a borehole or an underground well, into a main supply pipe 20 for delivery of the water into, for example, a reservoir. The main supply pipe 20 contains a flow meter FM and the system operator is thus aware of the sum of the flow rates achieved by the pumps and he may control the number of pumps operating at any one time to achieve the required rate of supply.

In the absence of flow meters in the lines 21, 22, 23 and 24 leading from the pumps P1, P2, P3 and P4 to the main supply pipe 20, the system operator will not be aware of the contribution to the total flow afforded by each pump and, if the overall requirements for the supply of water are such that at least two pumps are always operating at any one time, there will be no ready means for

calculating the efficiencies of the individual pumps and thereby achieving the most economical method of operation.

When, however, information concerning the pump power consumptions is obtained and curve 12 for each of the pumps is used, this will give an approximate indication of the flow rate contribution for each pump.

In addition, however, pressure transducers (not shown) are provided at the inlets and the outlets of each of the pumps, thus enabling the pressure head for each pump to be measured. The information thereby obtained concerning pump heads and flow rates can then be used to produce curves corresponding to curve 11. The degree of difference between such curves and the original curves 10 for each of the pumps will enable further calculations to be carried out so as to obtain more accurate figures for the actual flow rates for the individual pumps and also to generate curves corresponding to curves 15 showing the extent by which the performance or efficiency of each pump has been reduced as a result of wear.

The data which is obtained by the method described above not only enables the system operator to identify the flow rate contributions of the individual pumps but also provides a simple and cost-effective way of monitoring pump performance. This then enables pump maintenance and refurbishment programmes to be carried out in the most effective manner.

It will thus be possible to carry out an on-going monitoring programme from the data obtained by determining the inlet and outlet pressures of the individual pumps and the power consumptions of the pumps, and carrying out computations using such data.

Claims:-

1. A method of measuring the flow rate obtained during operation of a pump, which method comprises:-

- a) collating data concerning the power consumption of the pump and the flow rates obtained under initial or optimal conditions,
- b) obtaining information as to the actual power consumption of the pump during operation thereof, and
- c) comparing said information with the collated data (and carrying out any necessary calculations) to obtain a flow rate measurement.

2. A method as claimed in Claim 1, in which the data concerning the power consumption of the pump and the flow rates obtained under initial or optimal conditions is the data supplied by the pump manufacturer on initial installation of the pump.

3. A method as claimed in Claim 2, in which the relationship between the power consumption of the pump and the flow rates obtained during initial or optimal conditions is one of three curves supplied by the pump manufacturer to the user of the pump, the other two curves showing the relationship between the pump head and the pump flow rate and the relationship between the pump efficiency and the pump flow rate.

4. A method as claimed in Claim 3, in which, in the case of pumps which have complex power/flow curves, the method is

enhanced by cross-referencing the head/flow curve to the power/flow curve.

5. A method as claimed in Claim 1, substantially as hereinbefore described with reference to Figure 1 of the drawings.

6. A method as claimed in Claim 1, in which, where a plurality of pumps are arranged to operate in parallel so as to obtain a combined flow rate, the combined flow rate is measured using a flow meter and the flow rates attributable to the individual pumps are measured by determining the power consumptions of the individual pumps and carrying out the appropriate computations.

7. A method as claimed in Claim 6, substantially as hereinbefore described with reference to Figure 2 of the drawings.

8. A method of determining pump performance, which comprises the following steps:-

- a) measuring the flow rate of the pump by the method claimed in Claim 1,
- b) measuring the pump head,
- c) collating data concerning the pump head and the flow rates obtained under initial or optimal conditions, and
- d) comparing the results of said measurements with the collated data (and carrying out any necessary calculations) to obtain an indication of pump performance.

9. A method as claimed in Claim 8, in which pressure transducers are provided at the pump inlet and outlet to determine the pump head.

10. A method as claimed in Claim 8, substantially as hereinbefore described with reference to the drawings.



The
Patent
Office

H

Application No: GB 9709121.9
Claims searched: 1-10

Examiner: M. G. Clarke
Date of search: 1 July 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK CI (Ed.O): G1N NAAJD, NAAJR, NABF, NADW

Int CI (Ed.6): G01F 1/00, 1/34; G01L 3/26

Other: Online: WPI.

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	GB 2260406 A South West Water plc - whole document	1 at least
A	EP 0674154 A1 Bij de Leij etc - whole document	
X	US 4781525 assigned to Minnesota Mining etc - whole document	
X	US 4108574 assigned to International Paper Co - whole document	

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.

& Member of the same patent family

A Document indicating technological background and/or state of the art.
P Document published on or after the declared priority date but before the filing date of this invention.

E Patent document published on or after, but with priority date earlier than, the filing date of this application.